

1 **CLAIMS**

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3 1. A method comprising:

4 receiving a description of a system being designed;

5 receiving a description of an environment; and

6 using both of the received descriptions to validate the system against the

7 environment while the system is being designed and prior to attempting to deploy

8 the system.

9

10 2. A method as recited in claim 1, the description of the system

11 comprising an SDM document.

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13 3. A method as recited in claim 1, the description of the environment

14 comprising a LIM document.

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16 4. A method as recited in claim 1, the system comprising a software

17 application, and the environment comprising a data center.

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19 5. A method as recited in claim 1, the environment comprising an

20 environment where the system is expected to be deployed.

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1           6. One or more computer readable media having stored thereon a  
2 plurality of instructions that, when executed by one or more processors, causes the  
3 one or more processors to:

4           access a system description that describes a system in the process of being  
5 designed by a program running on the one or more processors; and

6           validate the system, using the system description, against a simulated  
7 environment.

8  
9           7. One or more computer readable media as recited in claim 6, the  
10 plurality of instructions further causing the processor to:

11           receive, from a requestor, a request to validate the system; and

12           return, to the requestor, a result of the validation.

13  
14           8. One or more computer readable media as recited in claim 6, wherein  
15 the instructions that cause the one or more processors to validate the system  
16 against the simulated environment further cause the one or more processors to:

17           select a top-level definition from the system description;

18           generate an appropriate instance, as described by the top-level definition,  
19 for an instance space;

20           select an additional definition nested within the top-level definition;

21           generate an appropriate instance, as described by the additional definition,  
22 for the instance space based on whether the selected definition defines an object or  
23 a relationship; and

1           continue the selection of an additional definition and the generation of an  
2 appropriate instance, as described by the additional definition, until instances for  
3 all of the definitions nested within the top-level definition have been generated for  
4 the instance space.

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6           **9.**    One or more computer readable media as recited in claim 6, wherein  
7 the instructions that cause the one or more processors to validate the system  
8 against the simulated environment further cause the one or more processors to:

9           identify one or more flows in an instance space, the instance space  
10 describing the system;

11          for each of at least one of the one or more flows:

12               identify one or more input values for the flow, the input values being  
13 obtained from other instances of the instance space; and

14               generate, based at least in part on the input values, an output value  
15 for the flow.

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17           **10.**   One or more computer readable media as recited in claim 6, wherein  
18 the instructions that cause the one or more processors to validate the system  
19 against the simulated environment further cause the one or more processors to:

20          identify one or more constraints in an instance space, the instance space  
21 describing the system;

22          check whether the one or more constraints are satisfied; and

23          return, for each of the one or more constraints, a value indicating whether  
24 the constraint is satisfied.

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2       **11.**     An apparatus comprising:  
3       a loader configured to load one or more documents describing a system, the  
4     system being designed when the one or more documents are loaded;  
5       a simulator configured to simulate an environment of a data center and  
6     validate the system against the environment; and  
7       the apparatus being separate from the data center.  
8

9       **12.**     An apparatus as recited in claim 11, further comprising:  
10      an expansion engine to identify a top-level definition from one of the one or  
11     more documents and expand the top-level definition to populate an instance space  
12     by instantiating members nested in the top-level definition.  
13

14      **13.**     An apparatus as recited in claim 12, further comprising:  
15      a flow engine to identify flows in the instance space, identify the values of  
16     inputs to the flows, and setting an output of the flow based on the inputs to the  
17     flows.  
18

19      **14.**     An apparatus as recited in claim 13, further comprising:  
20      a constraint engine to identify and evaluate constraints in the instance  
21     space.  
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1           **15.** One or more computer readable media having stored thereon a  
2 plurality of instructions that, when executed by one or more processors, causes the  
3 one or more processors to:

4           access a document that describes a system being designed to be used in an  
5 environment of a data center;

6           select a top-level definition from the document;

7           generate an appropriate instance, as described by the top-level definition,  
8 for an instance space;

9           select an additional definition nested within the top-level definition;

10          generate an appropriate instance, as described by the additional definition,  
11 for the instance space based on whether the selected definition defines an object or  
12 a relationship; and

13          continue the selection of an additional definition and the generation of an  
14 appropriate instance, as described by the additional definition, until instances for  
15 all of the definitions nested within the top-level definition have been generated for  
16 the instance space.

17  
18          **16.** One or more computer readable media as recited in claim 15,  
19 wherein the instructions that cause the one or more processors to generate an  
20 appropriate instance, as described by the additional definition, when the selected  
21 definition defines a relationship further cause the one or more processors to:

22          identify a number of relationship instances to create based on a number of  
23 source instances and a number of target instances involved in the defined  
24 relationship;

1           create the identified number of relationship instances; and  
2           for each of the created relationship instances, associate source and target  
3 instances with the relationship instance.  
4

5           **17.**   One or more computer readable media as recited in claim 16, the  
6 selected definition defining a containment relationship that describes that one  
7 instance can be contained in another instance.  
8

9           **18.**   One or more computer readable media as recited in claim 16, the  
10 selected definition defining a communication relationship that describes an  
11 interaction between independently deployed software elements.  
12

13           **19.**   One or more computer readable media as recited in claim 16, the  
14 selected definition defining a reference relationship used to capture dependencies  
15 between instances.  
16

17           **20.**   One or more computer readable media as recited in claim 16, the  
18 selected definition defining a hosting relationship that associates a host with one or  
19 more of its guest member instances.  
20

21           **21.**   One or more computer readable media as recited in claim 16, the  
22 selected definition defining a delegation relationship that associates  
23 communication endpoints of two systems.  
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1           **22.**   One or more computer readable media as recited in claim 15,  
2 wherein the instructions that cause the one or more processors to generate an  
3 appropriate instance, as described by the additional definition, when the selected  
4 definition defines an object further cause the one or more processors to:

5           identify a minimum number of occurrences of the object as identified in the  
6 selected definition;

7           identify a number of instances of the selected definition to generate based  
8 on the identified minimum number of occurrences and how many instances of the  
9 selected definition have already been generated; and

10          generate the identified number of instances of the selected definition.  
11

12           **23.**   One or more computer readable media as recited in claim 15,  
13 wherein the instructions that cause the one or more processors to generate an  
14 appropriate instance, as described by the additional definition, when the selected  
15 definition defines an object further cause the one or more processors to:

16          trigger an event that allows a listener to create the appropriate instance as  
17 described by the additional information.  
18

19           **24.**   One or more computer readable media as recited in claim 15,  
20 wherein the instructions that cause the one or more processors to generate an  
21 appropriate instance, as described by the additional definition, when the selected  
22 definition defines a relationship further cause the one or more processors to:

23          trigger an event that allows a listener to create the appropriate instance as  
24 described by the additional information.  
25

1  
2       **25.**   One or more computer readable media as recited in claim 15,  
3 wherein the instructions are to be executed prior to beginning deployment of the  
4 system in the data center.

5  
6       **26.**   One or more computer readable media having stored thereon a  
7 plurality of instructions that, when executed by one or more processors, causes the  
8 one or more processors to:

9       identify one or more flows in an instance space, the instance space  
10 describing a system being designed to be used in an environment of a data center;

11       for each of at least one of the one or more flows:

12           identify one or more input values for the flow, the input values being  
13 obtained from other instances of the instance space; and

14           generate, based at least in part on the input values, an output value  
15 for the flow.

16  
17       **27.**   One or more computer readable media as recited in claim 26,  
18 wherein the instructions that cause the one or more processors to identify one or  
19 more input values for the flow further cause the one or more processors to:

20       identify whether the input values have been assigned yet;

21       if the input values have been assigned then obtain the input values from the  
22 other instances;

23       if at least one of the input values has not been assigned yet then, for each of  
24 the input values that has not been assigned yet:



1                   identify one other flow that sets the input value;  
2                   identify one or more input values for the other flow, the input values  
3                   being obtained from other instances of the instance space; and  
4                   generate, based at least in part on the input values, an output value  
5                   for the other flow.

6  
7           **28.**    One or more computer readable media as recited in claim 26,  
8           wherein the instructions that cause the one or more processors to generate, based  
9           at least in part on the input values, the output value for the flow further cause the  
10          one or more processors to:

11               identify a set of instructions associated with the flow that can be executed  
12               to generate a result;  
13               execute the identified set of instructions; and  
14               use the generated result as the output value for the flow.

15  
16          **29.**    One or more computer readable media as recited in claim 26, the  
17          system comprising an application to be deployed in the environment.

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19          **30.**    One or more computer readable media as recited in claim 26, the  
20          environment comprising a hardware description of a data center.

1           **31.**    One or more computer readable media as recited in claim 26,  
2 wherein the instructions are to be executed prior to beginning deployment of the  
3 system in the environment.

4  
5           **32.**    One or more computer readable media having stored thereon a  
6 plurality of instructions that, when executed by one or more processors, causes the  
7 one or more processors to:

8                identify one or more constraints in an instance space, the instance space  
9 describing a system being designed to be used in an environment of a data center;

10               check whether the one or more constraints are satisfied; and

11               return, for each of the one or more constraints, a value indicating whether  
12 the constraint is satisfied.

13  
14           **33.**    One or more computer readable media as recited in claim 32, the  
15 one or more constraints including a setting constraint, a relationship constraint,  
16 and an object constraint.

17  
18           **34.**    One or more computer readable media as recited in claim 32,  
19 wherein the instructions that cause the one or more processors to check whether  
20 the one or more constraints are satisfied further cause the one or more processors  
21 to, for one of the constraints:

22                identify a set of instructions associated with the constraint that can be  
23 executed to generate a result;

24                execute the identified set of instructions; and  
25

1 use the generated result as the value returned indicating whether the  
2 constraint is satisfied.

3  
4 **35.** One or more computer readable media as recited in claim 32,  
5 wherein the instructions that cause the one or more processors to check whether  
6 the one or more constraints are satisfied further cause the one or more processors  
7 to, for one of the constraints:

8 identify a role and an object definition for a target instance of the  
9 constraint;

10 check whether the role and the object definition of the constraint match the  
11 role and the object definition of the target instance; and

12 generate, based on whether the role and the object definition of the  
13 constraint match the role and the object definition of the target instance, the value  
14 returned indicating whether the constraint is satisfied.

15  
16 **36.** One or more computer readable media as recited in claim 35,  
17 wherein the instructions that cause the one or more processors to check whether  
18 the one or more constraints are satisfied further cause the one or more processors  
19 to, for the one of the constraints:

20 identify a secondary role and a secondary object definition for the target  
21 instance of the constraint;

22 check whether the secondary role and the secondary object definition of the  
23 constraint match the role and the object definition of the target instance; and  
24  
25

1 generate, based on whether the role and the object definition of the  
2 constraint match both the role and the object definition of the target instance and  
3 the secondary role and the secondary object definition of the target instance, the  
4 value returned indicating whether the constraint is satisfied.

5  
6 **37.** One or more computer readable media as recited in claim 35,  
7 wherein the instructions that cause the one or more processors to check whether  
8 the one or more constraints are satisfied further cause the one or more processors  
9 to, for the one of the constraints:

10 evaluate one or more nested constraints for the target instance;  
11 receive one or more return values for the nested constraints, the one or  
12 more return values indicating whether the one or more nested constraints are  
13 satisfied; and  
14 generate, based on the one or more return values for the nested constraints,  
15 the value returned indicating whether the constraint is satisfied.

16  
17 **38.** One or more computer readable media as recited in claim 32,  
18 wherein the instructions that cause the one or more processors to return, for each  
19 of the one or more constraints, a value indicating whether the constraint is satisfied  
20 further cause the one or more processors to, for one of the constraints:

21 if a value indicating that the constraint is not satisfied is to be returned, then  
22 check whether an error message is to be generated for the constraint; and

23 if the error message is to be generated, then generate the error message  
24 including information identifying the constraint.

1  
2       **39.**    One or more computer readable media as recited in claim 32,  
3 wherein the instructions that cause the one or more processors to check whether  
4 the one or more constraints are satisfied further cause the one or more processors  
5 to, for one of the constraints:

6       initialize a match count variable;

7       identify one or more relationship instances that the target instance of the  
8 constraint participates in;

9       evaluate, for each of the one or more relationship instances, whether the  
10 relationship instance satisfies the constraint;

11       increment the match count variable for each of the one or more relationship  
12 instances that satisfies the constraint; and

13       generate, based on the value of the match count variable after the one or  
14 more relationship instances have been evaluated, the value returned indicating  
15 whether the constraint is satisfied.

16  
17       **40.**    One or more computer readable media as recited in claim 39,  
18 wherein the instructions that cause the one or more processors to evaluate, for each  
19 of the one or more relationship instances, whether the relationship instance  
20 satisfies the constraint further cause the one or more processors to, for the one of  
21 the constraints:

22       check whether a relationship definition of the constraint matches a  
23 relationship definition of the relationship instance;

1           check whether a direction of the constraint matches a direction of the  
2 relationship instance;

3           check whether all nested constraints for the relationship instance are  
4 satisfied; and

5           return a value indicating that the constraint is satisfied only if the  
6 relationship definition of the constraint matches the relationship definition of the  
7 relationship instance, the direction of the constraint matches the direction of the  
8 relationship instance, and all nested constraints for the relationship instance are  
9 satisfied.

10  
11           **41.** One or more computer readable media as recited in claim 39,  
12 wherein the instructions that cause the one or more processors to evaluate, for each  
13 of the one or more relationship instances, whether the relationship instance  
14 satisfies the constraint further cause the one or more processors to, for the one of  
15 the constraints:

16           check whether a target object of the constraint matches an instance at the  
17 other end of the relationship instance; and

18           return a value indicating that the constraint is satisfied only if the  
19 relationship definition of the constraint matches the relationship definition of the  
20 relationship instance, the direction of the constraint matches the direction of the  
21 relationship instance, all nested constraints for the relationship instance are  
22 satisfied, and the target object of the constraint matches the instance at the other  
23 end of the relationship instance.

1           **42.**   One or more computer readable media as recited in claim 39,  
2 wherein the instructions that cause the one or more processors to generate, based  
3 on the value of the match count variable after the one or more relationship  
4 instances have been evaluated, the value returned indicating whether the constraint  
5 is satisfied further cause the one or more processors to, for one of the constraints:

6           check whether the match count variable is at least a minimum value of the  
7 constraint but is not greater than a maximum value of the constraint; and

8           generate the value returned indicating that the constraint is satisfied if the  
9 match count variable is at least the minimum value of the constraint but is not  
10 greater than the maximum value of the constraint, otherwise generate the value  
11 returned indicating that the constraint is not satisfied.

12  
13  
14           **43.**   One or more computer readable media as recited in claim 32,  
15 wherein the instructions are to be executed prior to beginning deployment of the  
16 system in the environment.